Celebrating 100 Years
1914 MPU 2014
Manitowoc Public Utilities

1303 South 8th Street P.O. Box 1090 Manitowoc, WI 54221-1090 920-683-4600 FAX 920-686-4348 www.mpu.org

Mr. Randy Matty, P.E.
Air Management Engineer
Wisconsin Department of Natural Resources
2984 Shawano Ave.
Green Bay, WI 54313-6727

August 19, 2014

RE: B28 and B09 Compliance Stack Testing Notice

Dear Mr. Matty:

Manitowoc Public Utilities is planning to repeat the biennial PM stack testing of boilers B28 and B09 the week of September 8, 2014 as required by permit conditions LD.l.b.(4) and LE.l.b.(7). The Emission Compliance Test Protocol No. 4784B prepared by AIRTECH Environmental Services Inc. for Manitowoc Public Utilities previously submitted will be used for this test.

The proposed stack testing schedule is as follows:

- September 8th (Monday) Test team travel to and set up at MPU **(Arrive by 12:00 pm)**
- September 9th (Tuesday) B28 Compliance particulate matter stack testing, PM2.5, total PM
    - Compliance PM Stack Test (3-runs) @ 8:00 am – 5:00 pm
- September 10th (Wednesday) B9 Compliance particulate matter stack testing, PM2.5, total PM
    - Compliance PM Stack Test (3-runs) @ 8:00 am – 5:00 pm
- September 11th (Thursday) Pack up and go @ 8:00 am, Make-up day if needed

Please call if you have any questions regarding the stack testing, or require additional information.

Sincerely,

Thomas E Reed

Thomas E. Reed, P.E.
Environmental Engineer
Manitowoc Public Utilities
Phone: 920-686-4384
Cell: 920-973-7134
Fax: 920-686-4348

Cc:
Red Jones – MPU
Jerry Ahlswede – MPU
Brian Fassbender – MPU
Tim Harding – MPU
Scott Karbon – MPU
Adam Becker – MPU

Source: Y:\Group File Folders\Reed\1-Tom Reed\Air\stack testing\2014 B28 & B09 Test\September Retest\WDNR stack test Protocol cover letter.docx

File: PowerPlant/Regulatory - Environmental/Correspondence/WDNR
Document: 2014-08-19 (WDNR) B8 and B9 Stack Test Notice

8/19/2014

Protocol for the Air Emissions Test Program

To be conducted for
Manitowoc Public Utilities
At the Manitowoc Power Plant
Facility ID 436035930
Located at
701 Columbus Street
Manitowoc, Wisconsin 54220

Protocol No. 4784B
August 13, 2014

Table of Contents

Project Overview

General

Airtech Environmental Services Inc. (Airtech) has been contracted by Manitowoc Public Utilities (MPU) to perform an air emissions test program at the MPU Power Plant (Facility ID 436035930) located in Manitowoc, Wisconsin. The specific objectives of this test program are as follows:

- Perform compliance testing to determine the concentrations of total filterable particulate matter (FPM), FPM less than a nominal aerodynamic diameter of 2.5 microns ($PM_{2.5}$) and condensable particulate matter (CPM) from the exhausts of two (2), circulating, fluidized-bed boilers designated as Boiler 8 (B28) and Boiler 9 (B09)

Testing will be performed to meet the requirements of MPU; the Wisconsin Department of Natural Resources (WDNR); and the United States Environmental Protection Agency (US EPA), as applicable.

Testing will be conducted by Airtech Environmental Services Inc. Coordinating the test program will be:

Thomas Reed	**Brandon Check**
Manitowoc Public Utilities	Airtech Environmental Services Inc.
701 Columbus Street	1371 Brummel Ave.
Manitowoc, WI 54220	Elk Grove Village, IL 60007
Phone: (920) 686-4384	Phone: (630) 860-4740
email: tomreed@mpu.org	email: bcheck@airtechenv.com

Methodology

EPA Method 5 combined with EPA Method 202 will be used to determine the concentration of FPM, filterable $PM_{2.5}$ and CPM at the exhaust of boilers B28 and B09. For this project, all FPM collected with the Method 5 fraction of each sampling train will be assumed to be filterable $PM_{2.5}$. The sum of the FPM and CPM will be considered representative of the total particulate matter (PM) results.

In EPA Methods 5/202, a sample of the gas stream is withdrawn isokinetically from the source. FPM will collect in a glass probe and on a glass fiber filter. CPM will pass through the probe and filter assemblies and collect in a dry impinger system. Results for PM will be expressed in units of grains per dry standard cubic foot (gr/dscf), pounds per hour (lb/hr) and in units of pounds per million British thermal units (lb/MMBtu). Analysis for PM will be conducted at the Airtech laboratory located in Elk Grove Village, Illinois. Three (3), approximately one-hundred-twenty (120) minute test runs will be performed at each test location such that a minimum of 60 dscf is sampled.

In order to convert the various concentrations of PM to mass emissions rates, the volumetric gas flow rate through the test location will be determined concurrently with each test run, using EPA Methods 1, 2, 3B and 4.

Special Considerations

The compliance PM testing of Boilers 28 and 09 will be conducted:

1. The configuration for the particulate train to determine total particulate emissions will be as follows:
   - Glass lined probe (heated to 320F +/- 25F)
   - Filter (heated to 320F +/- 25F)
   - Impinger train setup per USEPA Method 202 requirements
2. Sampling will be performed at the Method 1 required test points with a minimum of 60 dry standard cubic feet sampled, and an isokinetic variance of between 90%-110%.
3. Compliance testing to consist of three runs, each of which will be a minimum of 120 minutes.
4. Probe, train and sample recovery jars will be constructed of glass.
5. All laboratory recovery and analysis vessels will be constructed of glass.
6.

Parameters

The following parameters will be determined at the exhaust of Boilers 28 and 09:

- oxigen concentration
- carbon dioxide concentration
- filterable particulate matter concentration
- condensable particulate matter concentration

Test Schedule

Test dates to be determined.

Date	Location	Activity	Test Method	No. of Runs
1	Manitowoc, WI Boiler 9 (B09)	Mobilize to job site Set up test equipment		
2	Boiler 9 (B09)	Perform compliance PM testing	EPA M1, 2, 3B, 4 & 5/202	3 (120 min. each)
3	Boiler 8 (B28)	Set up test equipment		
4	Boiler 8 (B28)	Perform compliance PM testing Breakdown test equipment Demobilize from job site	EPA M1, 2, 3B, 4 & 5/202	3 (120 min. each)
5		Contingency Day		

Test Procedures

Method Listing

The test methods found in 40 CFR Part 60, Appendix A and 40 CFR Part 51, Appendix M will be referenced for the test program. The following individual methods will be referenced:

Method 1	Sample and velocity traverse for stationary sources
Method 2	Determination of stack gas velocity and volumetric flow rate (type S pitot tube)
Method 3	Determination of oxygen and carbon dioxide concentrations in emissions from stationary sources
Method 4	Determination of moisture content in stack gases
Method 5	Determination of particulate matter emissions from stationary sources
Method 19	Determination of sulfur dioxide, nitrogen oxide and carbon monoxide emission rates
Method 202	Dry impinger method for determining condensable particulate emissions from stationary sources

Method Descriptions

Method 1

EPA Method 1 will be used to determine the suitability of the sampling locations and to determine the traverse points used for the volumetric flow rate and PM determinations. The test locations must conform to the minimum requirement of being at least 2.0 diameters downstream and at least 0.5 diameters upstream from a flow disturbance.

Method 2

EPA Method 2 will be used to determine the gas velocity through each test location using a type S pitot tube and an incline plane oil manometer. The manometer will be leveled and “zeroed” prior to each test run. The sample train will be leak checked before and after each run by pressurizing the positive side, or “high” side, of the pitot tube and creating a deflection on the manometer of at least three in. H_2O. The leak check will be considered valid if the manometer remains stable for 15 seconds. This procedure will be repeated on the negative side too. The velocity head pressure and gas temperature will then be determined at each point specified in Method 1. The static pressure of the duct will be measured using a water filled U-tube manometer. In addition, the barometric pressure will be measured and recorded. A diagram of the Method 2 apparatus is shown as part of the Method 5/202 sample train in Figure 3 of the Appendix.

Method 3

The carbon dioxide and oxygen contents will be determined at the exhaust of B28 and B9 using EPA Method 3. A gas sample will be collected into a Tedlar bag from the back of each 5/202 sample train for the duration of each test run. Analysis will be performed using an Orsat gas analyzer within eight hours of collection. The Orsat and operator will be validated by analyzing at least one bag filled with an EPA protocol mixture of oxygen and carbon dioxide in a balance of nitrogen.

The analyzer will be leak checked prior to analysis by raising the liquid levels in each pipette to a reference mark on the capillary tubes and then closing the pipette valves. The burette solution will then be raised to bring the meniscus onto the graduated portion of the burette and the manifold valve will be closed. A leak check will be considered valid if the pipette meniscus does not fall below the reference mark and the burette meniscus does not fall by more than 0.2 ml after four minutes.

The carbon dioxide content and oxygen content will be used to calculate the dry molecular weight of the gas stream. The molecular weight will then be used, along with the moisture content determined by EPA Method 4, for the calculation of the volumetric flow rate. For these calculations, the balance of the gas stream is assumed to be nitrogen since the other gas stream components are insignificant for the purposes of calculating molecular weight.

Method 4

The moisture content at each test location will be determined using EPA Method 4. A known volume of sample gas will be withdrawn from the source and the moisture will be condensed and measured. The dry standard volume of the sample gas will then be compared to the volume of moisture collected to determine the moisture content of the sample gas.

EPA Method 4 will be operated in conjunction with EPA Methods 5/202.
To condense the water vapor, the gas sample will pass through a series of glass impingers. The impingers will be charged as outlined in method 5/202.

The sample train will be leak checked prior to the test run by capping the probe tip and pulling a vacuum greater than the highest vacuum expected during the test run. A leak check will be considered valid if the leak rate is less than 0.02 cubic feet per minute or four percent of the average sample rate. Sample gas will then be withdrawn from the source at a rate not exceeding 0.75 cubic feet per minute such that a minimum sample volume of 21 dry standard cubic feet will be collected. The gas meter reading, gas meter inlet and outlet temperatures, gas meter static pressure and pump vacuum will be recorded every five minutes during each test run.

After the test run the sample train will be leak checked at the highest vacuum encountered during the test run. The amount of water collected in the condenser system will be measured volumetrically with a graduated cylinder and the silica gel weight gain will be determined gravimetrically. The net weight gain of water will be converted to a volume of wet gas and then compared to the amount of dry gas sampled to determine the moisture content. The moisture content will be used, along with the O_2 and CO_2 concentrations determined using EPA Method 3, for the calculation of the volumetric flow rate.

Method 19

EPA Method 19 will be used to calculate pollutant emission rates in terms of pounds per million Btu (lb/MBtu). The calculation will be based on the oxygen content of the sample gas and an appropriate F factor, which is the ratio of combustion gas volumes to heat inputs.

EPA Methods 5/202

EPA Methods 5 and 202 will be used to determine the particulate concentration at the exhaust of boilers B09 and B28. A sample of the gas stream will be withdrawn isokinetically from the stack and the particulate matter in the sample gas stream will collect in a glass probe and on a glass fiber filter. In addition, condensible particulate matter will be collected in a gas condenser system. The weight of particulate collected with the sample train combined with the volume of dry gas withdrawn from the stack is then used to calculate the total particulate concentration. Concentrations will be determined for the suspended particulate collected in the front-half of the sample train as well as the organic and inorganic condensable particulate collected in the back-half of the sample train. A diagram showing the major components of the sample train used for EPA Methods 2, 3, 4, 5 and 202 is shown in Figure 3 of the appendix.

To prevent contamination, all components of the sample train will be constructed of glass with no metal connections. Prior to testing the nozzle, probe and front-half of the filter holder will be washed using detergent and then rinsed with tap water, deionized water and lastly with acetone. The back-half of the filter holder, impingers and connecting glassware will be washed using detergent and then rinsed with tap water, deionized water and lastly with methylene chloride. After drying, all components will be sealed with parafilm or Teflon tape.

The sample probe to be used will consist of a glass liner and glass nozzle. Sample gas will pass through the nozzle and probe assembly and then through a glass fiber filter heated to 320°F (+/- 25°F). After exiting the filter, the sample gas will pass through the condenser system described in Method 4. The dry gas exiting the moisture condenser system will then pass through a sample pump and a dry gas meter to measure the gas volume. After leaving the dry gas meter the sample stream will pass through an orifice which will be used to meter the flow rate through the sample train. The pressure drop across the orifice will be measured with an incline plane oil manometer.

85mm Whatman glass fiber filters will be used as the substrate for the particulate sampling. The filter will be loaded into a glass filter holder with a Teflon support screen that was prepared in the same manner as the other components of the sample train. Prior to the test run, the filter will be desiccated for at least 24 hours and then weighed to the nearest 0.0001g until a constant weight is achieved. The weight of the filter will be considered constant only when two consecutive weights taken at least six hours apart are within 0.0005g of each other. To eliminate interference in establishing a constant weight, both the analytical balance and the desiccators will be equipped with an ion generating polonium strip designed to eliminate static electricity that may collect on the samples.

The probe will be thoroughly pre-cleaned with acetone and the probe wash saved as a quality assurance check. The condenser system will then be prepared as outlined in Method 4. The sample train will be leak checked prior to the test run by capping the probe tip and pulling a vacuum of at least 15 in.Hg. A leak check will be considered valid if the leak rate is below four percent of the average sample rate or approximately 0.02 cfm. When not in operation inside the stack, the nozzle will be sealed with Teflon tape.

The probe tip will then be placed at each of the sample points determined in Method 1. The velocity at the sample point will be determined using Method 2 by reading the velocity pressure from the manometer. Sample will be withdrawn from the source at a rate such that the velocity at the opening of the nozzle is equivalent to the velocity of the stack gas at the sample point (isokinetically). During the test run the train will be moved to each of the Method 1 sample points. The sample time at each point will be calculated based on the number of sample points and the maximum allowable run time. The gas velocity pressure (ΔP), gas meter reading, gas meter inlet and outlet temperatures, gas meter orifice pressure (ΔH) and pump vacuum was recorded for each sample point. Each test run will at least one hour in duration.

After the test run the train will be leak checked at the highest vacuum encountered during the test run. The probe liner and nozzle will be rinsed with acetone and the rinse saved in a pre-cleaned amber glass jar with a Teflon lined lid. The condensate weight gain of the impinger contents will be determined as outlined in Method 4. The impingers and all connecting glassware will be rinsed twice with DUIF water. The condensate and rinse will be saved in a pre-cleaned amber glass jar with a Teflon lined lid. A final rinse of the above components will be performed with methylene chloride and saved in a separate a pre-cleaned amber glass jar with Teflon lined lid. The filter will be removed from the filter holder and placed in a labeled petri dish.

Analysis of the samples for particulate matter will be performed at Airtech located in Elk Grove Village, Illinois. The probe rinses will be transferred to a tared Teflon beaker liner, evaporated to dryness under ambient temperature and pressure conditions, desiccated for 24 hours and weighed to a constant weight. The filters will be desiccated for 24 hours and weighed to a constant weight. The weight gain of the probe rinse and filters yield the total weight of suspended particulate collected.

The collected condensate and rinse will be extracted by adding the contents of the methylene chloride rinse to the impinger water, and separating the layers in a separatory funnel. Two additional 75 ml portions of methylene chloride will be added to the funnel to complete the extraction. The organic extract fraction will be placed into a tared beaker and evaporated at room temperature to dryness. The beakers will then be desiccated for 24 hours and weighed to a constant weight. The aqueous inorganic fraction will be placed into a tared beaker, taken to dryness at a slightly elevated temperature, and allowed to air dry at room temperature. The residue will be desiccated for 24 hours and weighed to a constant weight. The weight differentials for the organic and inorganic fractions will be combined to determine the total condensible particulate collected. All fractions of the particulate analysis will be adjusted for the appropriate blank values.

Description of Installation

Manitowoc Public Utilities (MPU) is an electric cogenerating facility located in the City of Manitowoc Wisconsin. This plant includes two atmospheric pressure, circulating fluidized bed (CFB) boilers, designated as Boilers 8 (B28) and 9 (B09). Boiler 8 was installed in 1990, and is permitted to fire coal, petroleum coke, paper pellets, biomass, rubber waste derived fuels, natural gas, or other alternative fuels as approved by the Department. The Foster Wheeler Fluidized Bed Boiler is rated at 200,000 lbs. of superheated steam per hour at 975 psig and 905 degrees F. It is equipped with an economizer and air preheater and exhausts through a baghouse.

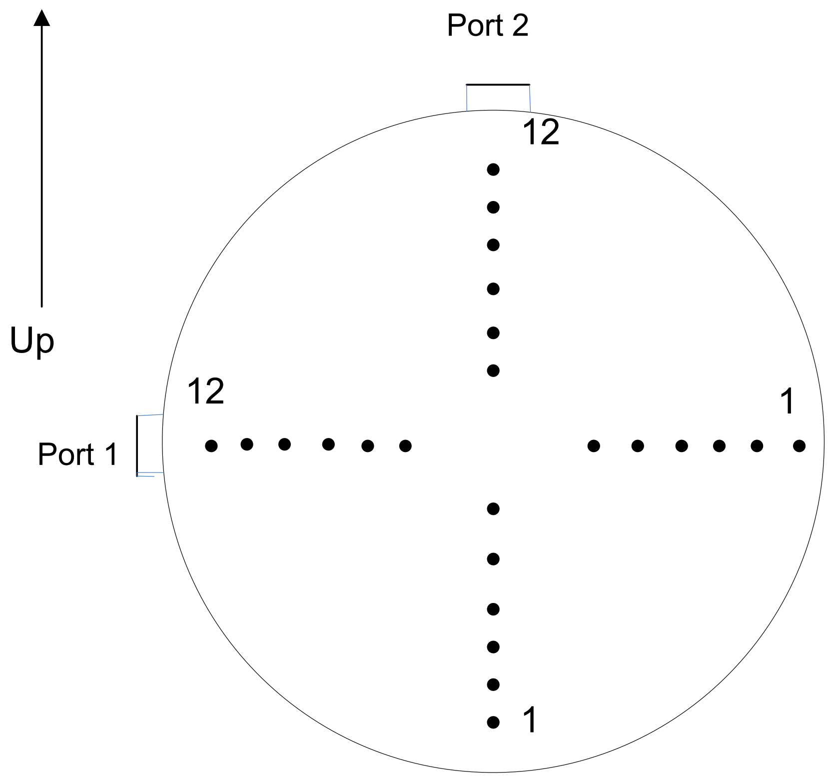
Boiler 8 (B28) was approved by the WDNR to be stack tested in the ductwork. A diagram for the unit ductwork is attached with the method 1 in the appendix. These diagrams show the breaching from the outlet of the I.D. fan to the stack outlet for B28. The test port detail drawing is also provided.

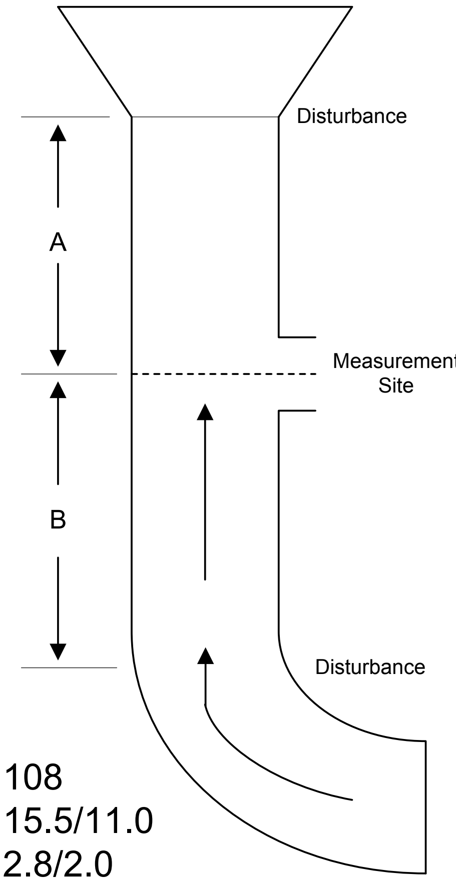
Boiler 9 (B09) was installed in 2004, and is permitted to fire coal, petroleum coke, renewable biomass and natural gas (start-up and load stabilization.) The Kvaerner/Mesto Fluidized Bed Boiler is rated at 475,000 lbs. of superheated steam per hour at 1,500 psig and 1,000 degrees F. It is equipped with an air preheater and exhausts through a baghouse.

Boiler 9 (B09) has a 9-foot diameter exhaust. The diagram for the unit's ductwork is attached with the B09 method 1 in the appendix. The drawings include the testing platform and test port details.

Appendix

Figures





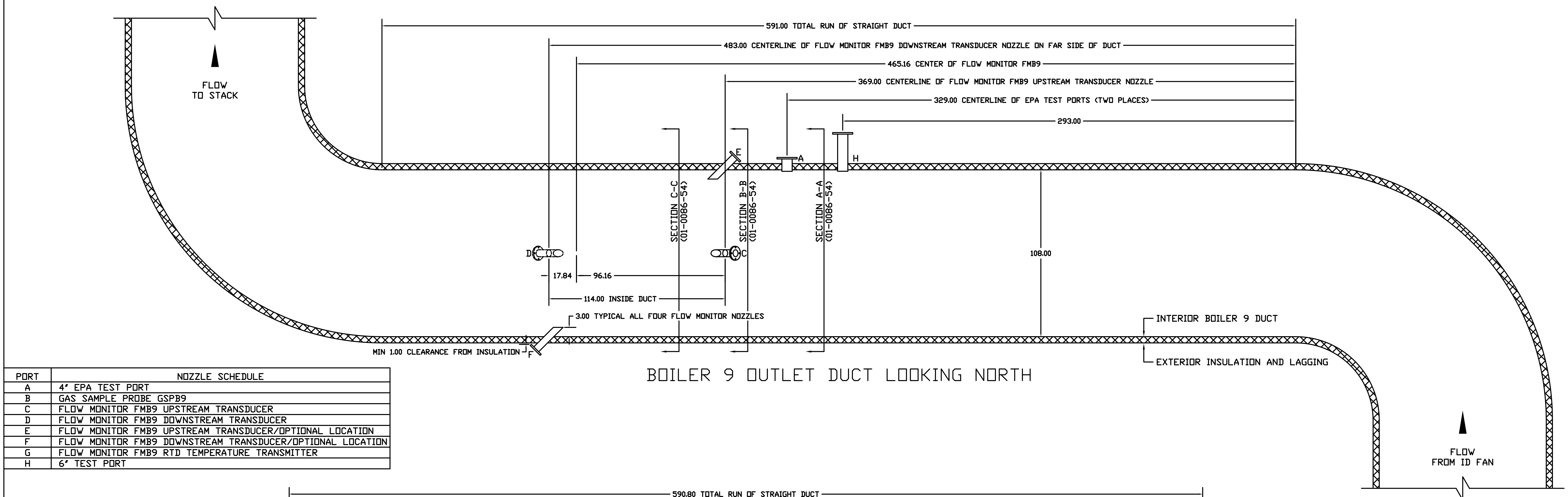
Diameter (in.)	108
Port Length (in.)	15.5/11.0
Distance A (Duct Diameters)	2.8/2.0
Distance B (Duct Diameters)	2.8/3.3

Point	Distance From Wall (in.)
1	2.3
2	7.2
3	12.8
4	19.1
5	27.0
6	38.4
7	59.6
8	81.0
9	88.9
10	95.2
11	100.8
12	105.7

Cross Section of the Boiler B09 Test Location
Manitowoc Public Utilities

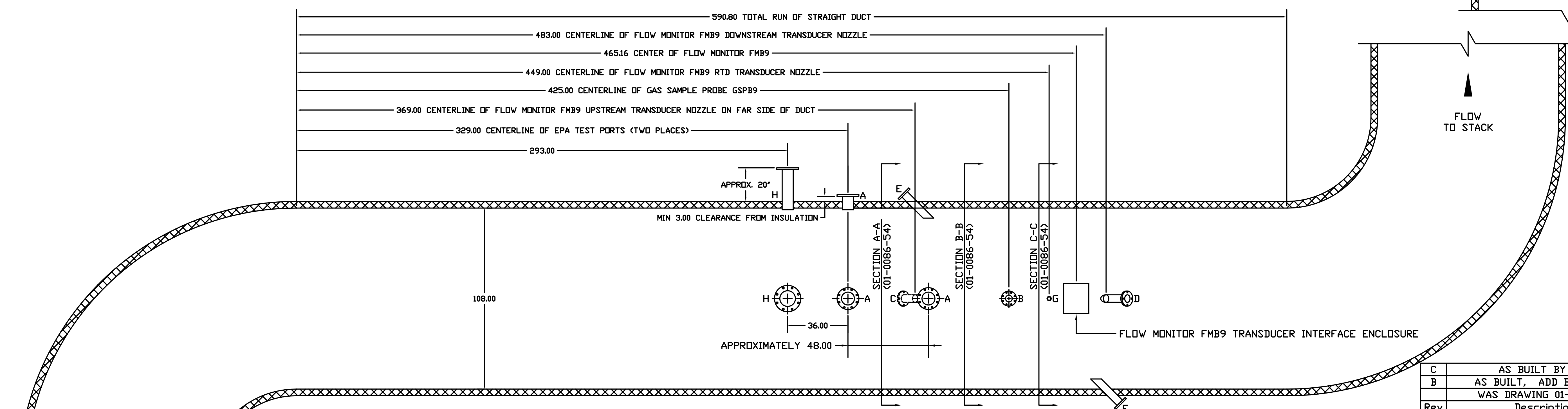
Figure 1

AIRTECH Environmental Services Inc.



BOILER 9 OUTLET DUCT LOOKING NORTH

PORT	NOZZLE SCHEDULE
A	4" EPA TEST PORT
B	GAS SAMPLE PROBE GSPB9
C	FLOW MONITOR FMB9 UPSTREAM TRANSDUCER
D	FLOW MONITOR FMB9 DOWNSTREAM TRANSDUCER
E	FLOW MONITOR FMB9 UPSTREAM TRANSDUCER/OPTIONAL LOCATION
F	FLOW MONITOR FMB9 DOWNSTREAM TRANSDUCER/OPTIONAL LOCATION
G	FLOW MONITOR FMB9 RTD TEMPERATURE TRANSMITTER
H	6" TEST PORT



BOILER 9 OUTLET DUCT LOOKING SOUTH

FLOW FROM ID FAN

NOTES:

9. INSIDE DIAMETER OF DUCT AT GAS SAMPLE PROBE PORT IS 108.0".
10. INSIDE DIAMETER OF DUCT AT FLOW MONITOR PORTS IS 108.0".
11. INSIDE DIAMETER OF DUCT AT EPA TEST PORTS IS 108.0".
12. THE HORIZONTAL OFFSET BETWEEN THE UPSTREAM AND DOWNSTREAM FLOW MONITOR NOZZLES IS 108.0" ON THE INSIDE OF THE DUCT.

NOTES:

1. SEE DRAWING 01-0086-54 FOR ORIENTATION AND LOCATION OF GAS SAMPLE PROBE PORT, EPA TEST PORTS, AND FLOW MONITOR PORTS ON BOILER 9 OUTLET DUCT.
2. ALL NOZZLES ON SIDE OF DUCT ARE ON THE HORIZONTAL CENTERLINE OF DUCT.
3. CENTERLINE OF GAS SAMPLE PROBE PORT TO NEAREST UPSTREAM OBSTRUCTION (ID FAN OUTLET ELBOW) IS 425.00 INCHES OR 3.94 EQUIVALENT DUCT DIAMETERS.
4. CENTERLINE OF GAS SAMPLE PROBE PORT TO NEAREST DOWNSTREAM OBSTRUCTION (ELBOW) IS 166.00 INCHES OR 1.54 EQUIVALENT DUCT DIAMETERS.
5. CENTERLINE OF FLOW MONITOR FMB9 TO NEAREST UPSTREAM OBSTRUCTION (ID FAN OUTLET ELBOW) IS 465.00 INCHES OR 4.31 EQUIVALENT DUCT DIAMETERS.
6. CENTERLINE OF FLOW MONITOR FMB9 TO NEAREST DOWNSTREAM OBSTRUCTION (ELBOW) IS 126.00 INCHES OR 1.17 EQUIVALENT DUCT DIAMETERS.
7. CENTERLINE OF EPA TEST PORTS TO NEAREST UPSTREAM OBSTRUCTION (ID FAN OUTLET ELBOW) IS 329.00 INCHES OR 3.05 EQUIVALENT DUCT DIAMETERS.
8. CENTERLINE OF EPA TEST PORTS TO NEAREST DOWNSTREAM OBSTRUCTION (ELBOW) IS 262.00 INCHES OR 2.43 EQUIVALENT DUCT DIAMETERS.

Rev	Description	Date
C	AS BUILT BY MPU	04-19-10
B	AS BUILT, ADD BOILER 8, WAS DRAWING 01-0086-53	12-01-04
	Revision	

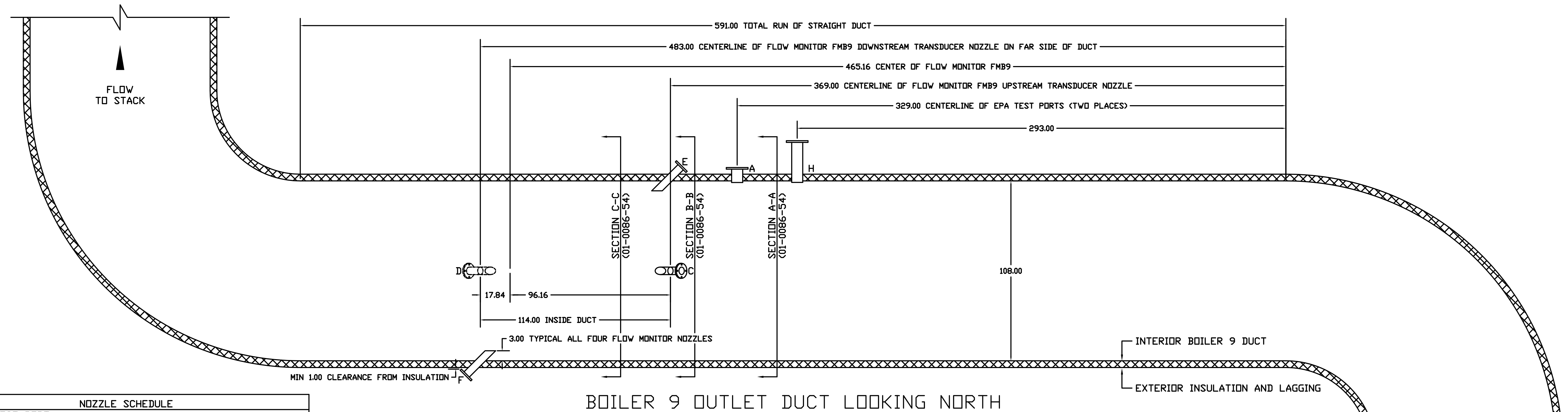
MSI MECHANICAL SYSTEMS, INC.
MECHANICAL SYSTEMS, INC.
480 PROGRESS WAY
SUN PRAIRIE, WISCONSIN 53590

PROJECT: CONTINUOUS EMISSION MONITORING SYSTEMS
COLUMBUS STREET POWER PLANT - BOILERS 8/9
MANITOWOC PUBLIC UTILITIES
MANITOWOC, WISCONSIN

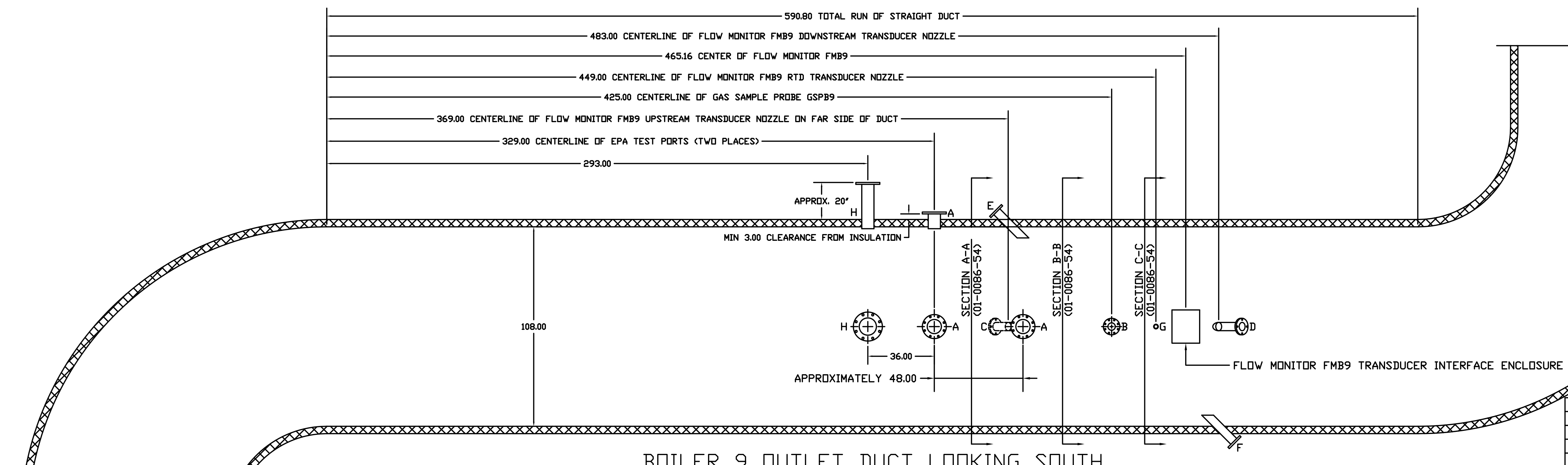
DIMENSION UNITS: INCHES	MSI CLAIMS PROPRIETARY RIGHTS TO THIS DRAWING. THIS DRAWING SHALL NOT BE REPRODUCED OR USED FOR ANY PURPOSE WITHOUT DIRECT WRITTEN PERMISSION FROM MSI TO THE USER. USE OF THIS DRAWING IN ANY WAY DETRIMENTAL TO MSI IS PROHIBITED.	DRAWN BY: JLA
DECIMAL TOLERANCE: .XX ± .5		CHECKED BY: CEA
ANGULAR TOLERANCE: ± .5°		APPROVED BY: JLA
SCALE: NTS		DATE: 29 DECEMBER 2003

TITLE: DUCT DETAILS
BOILER 9 GENERAL ARRANGEMENT

DRAWING NUMBER: 01-0086-61B



PORT	NOZZLE SCHEDULE
A	4" EPA TEST PORT
B	GAS SAMPLE PROBE GSPB9
C	FLOW MONITOR FMB9 UPSTREAM TRANSDUCER
D	FLOW MONITOR FMB9 DOWNSTREAM TRANSDUCER
E	FLOW MONITOR FMB9 UPSTREAM TRANSDUCER/OPTIONAL LOCATION
F	FLOW MONITOR FMB9 DOWNSTREAM TRANSDUCER/OPTIONAL LOCATION
G	FLOW MONITOR FMB9 RTD TEMPERATURE TRANSMITTER
H	6" TEST PORT



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NOTES:

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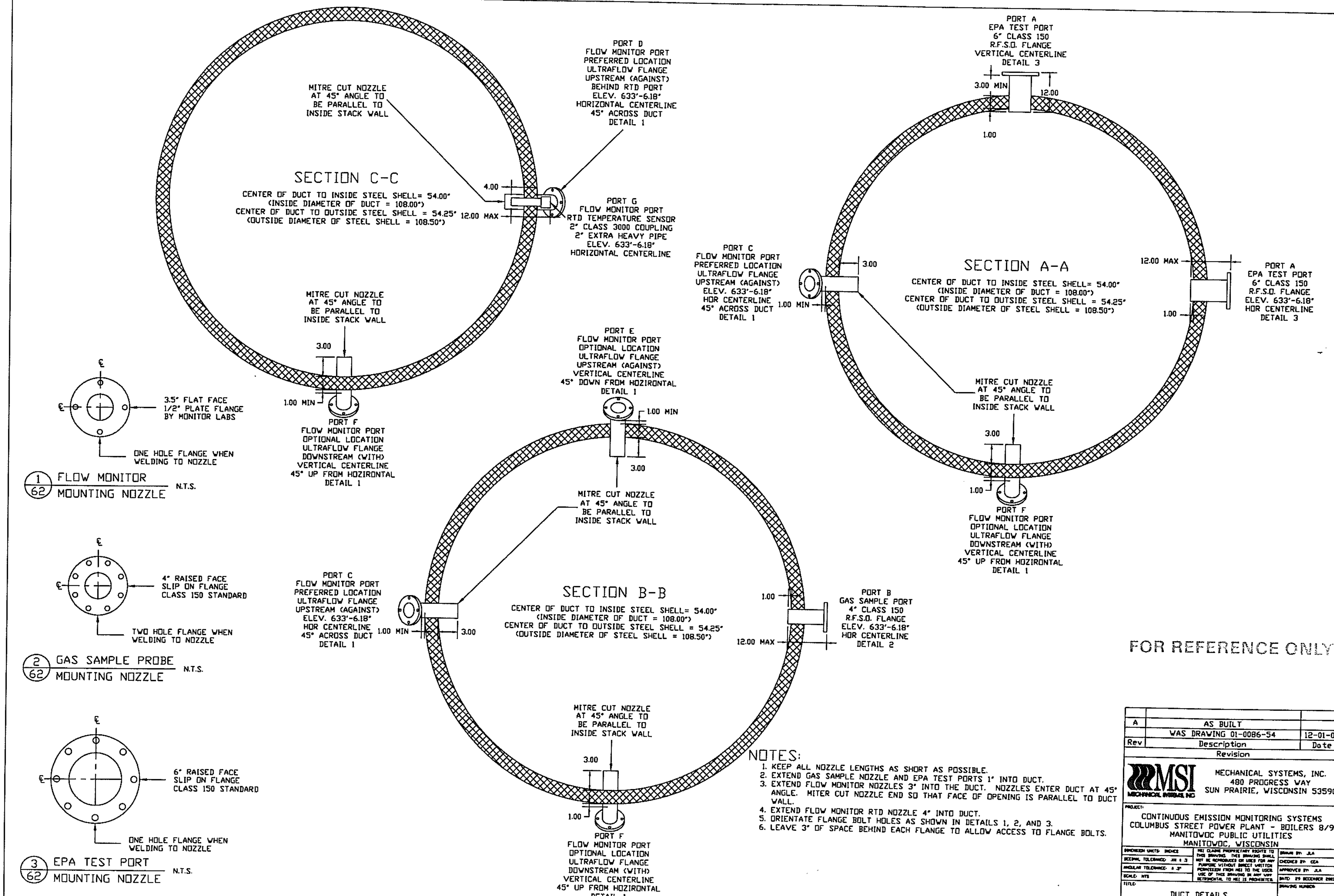
01-0086-61B



NOTES:

1. KEEP ALL NOZZLE LENGTHS AS SHORT AS POSSIBLE.
2. EXTEND GAS SAMPLE NOZZLE AND EPA TEST PORTS 1" INTO DUCT.
3. EXTEND FLOW MONITOR NOZZLES 3" INTO THE DUCT. NOZZLES ENTER DUCT AT 45° ANGLE. MITER CUT NOZZLE END SO THAT FACE OF OPENING IS PARALLEL TO DUCT WALL.
4. EXTEND FLOW MONITOR RTD NOZZLE 4" INTO DUCT.
5. ORIENTATE FLANGE BOLT HOLES AS SHOWN IN DETAILS 1, 2, AND 3.
6. LEAVE 3" OF SPACE BEHIND EACH FLANGE TO ALLOW ACCESS TO FLANGE BOLTS.

FOR REFERENCE ONLY

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A	AS BUILT WAS DRAWING 01-0086-54	12-01-04

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ANGULAR TOLERANCE: ± .5°
SCALE: NTS

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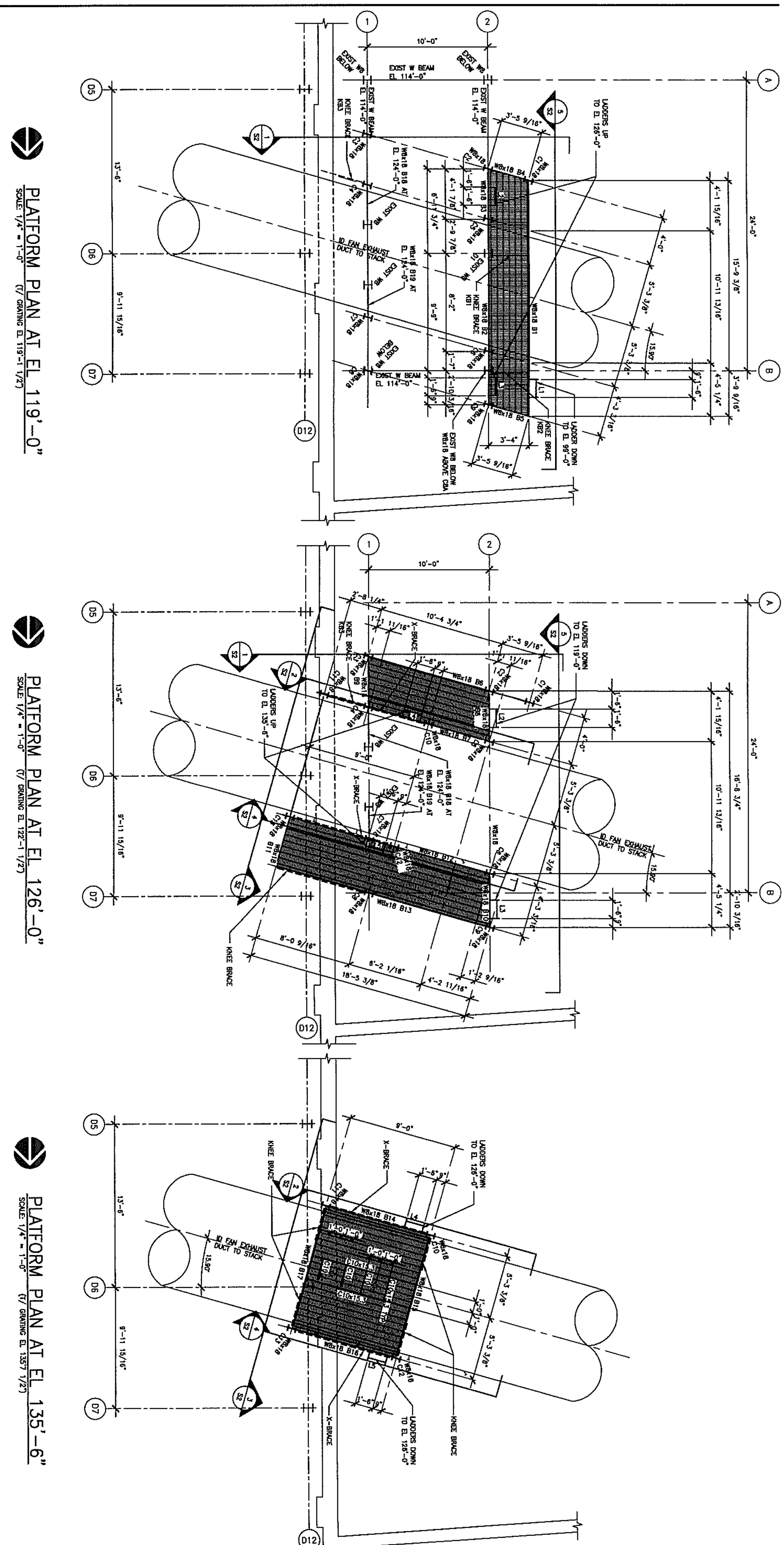
DRAWN BY: JLA
CHECKED BY: CEA
APPROVED BY: JLA
DATED: 29 DECEMBER 2003

TITLE:
DUCT DETAILS
PORTS AND NOZZLES

DRAWING NUMBER:
01-0086-62A



DWG RELEASE RECORD		
#	DATE	PURPOSE
0	8/11/05	FOR CONSTRUCTION
1	8/24/05	GENERAL REVISION

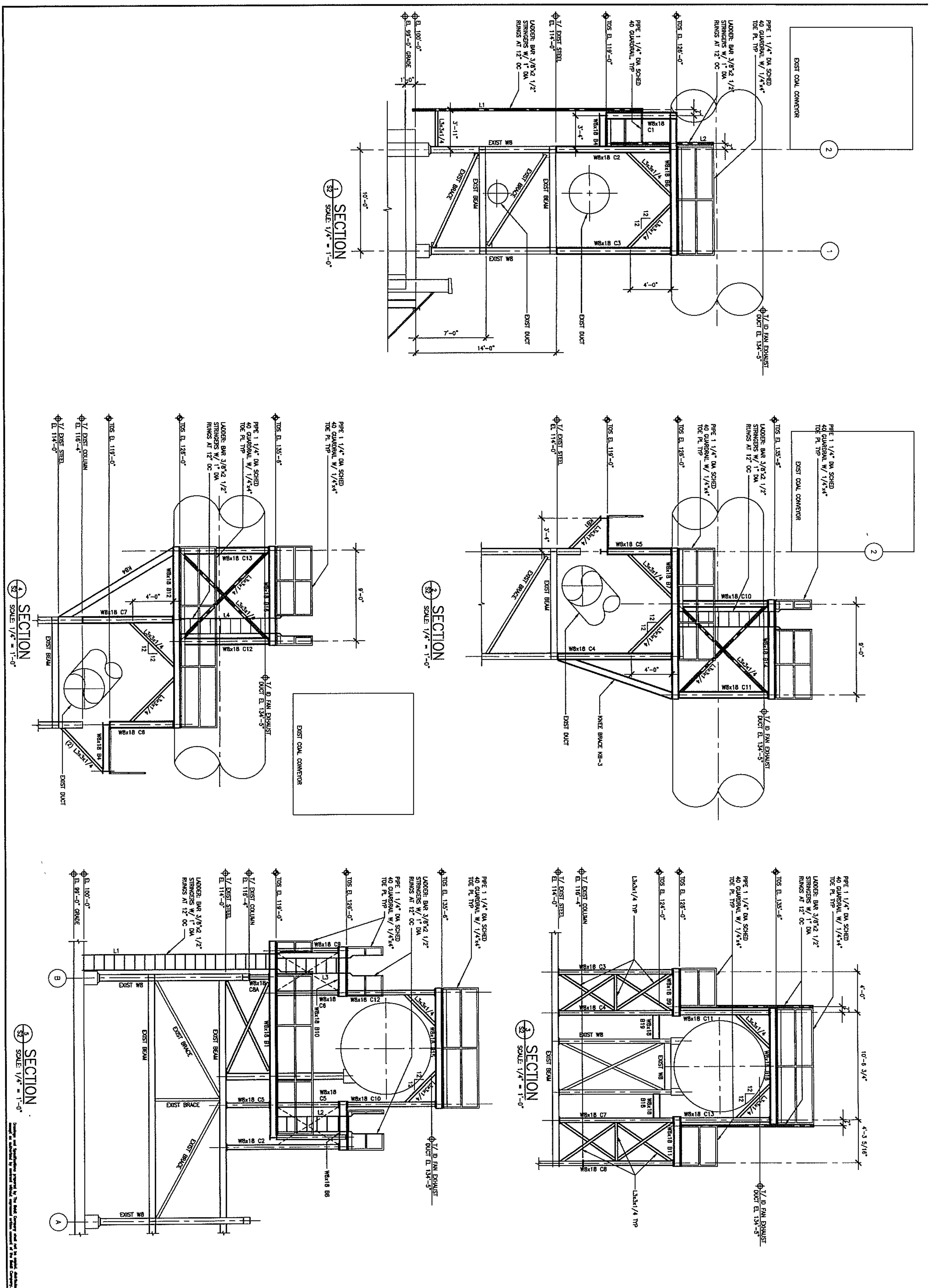
PROJECT NO. 88881
FILENAME 88881-S1
DRWN BY pd
CHK'D BY mdr
DRAWING NO. S1

ACCESS PLATFORMS PLANS

GENERATOR BUILDING
DUCT ACCESS PLATFORMS
MANITOWOC PUBLIC UTILITY
MANITOWOC, WO

BOLDT Technical Services
2525 N. ROEMER RD. P.O. BOX 419
APPLETON, WI 54912-0419 920-739-63

\DATA\Manitowoc Public Utility\05-88881\88881-S2.dwg, Full Size, 8/24/2005 10:11:51 AM



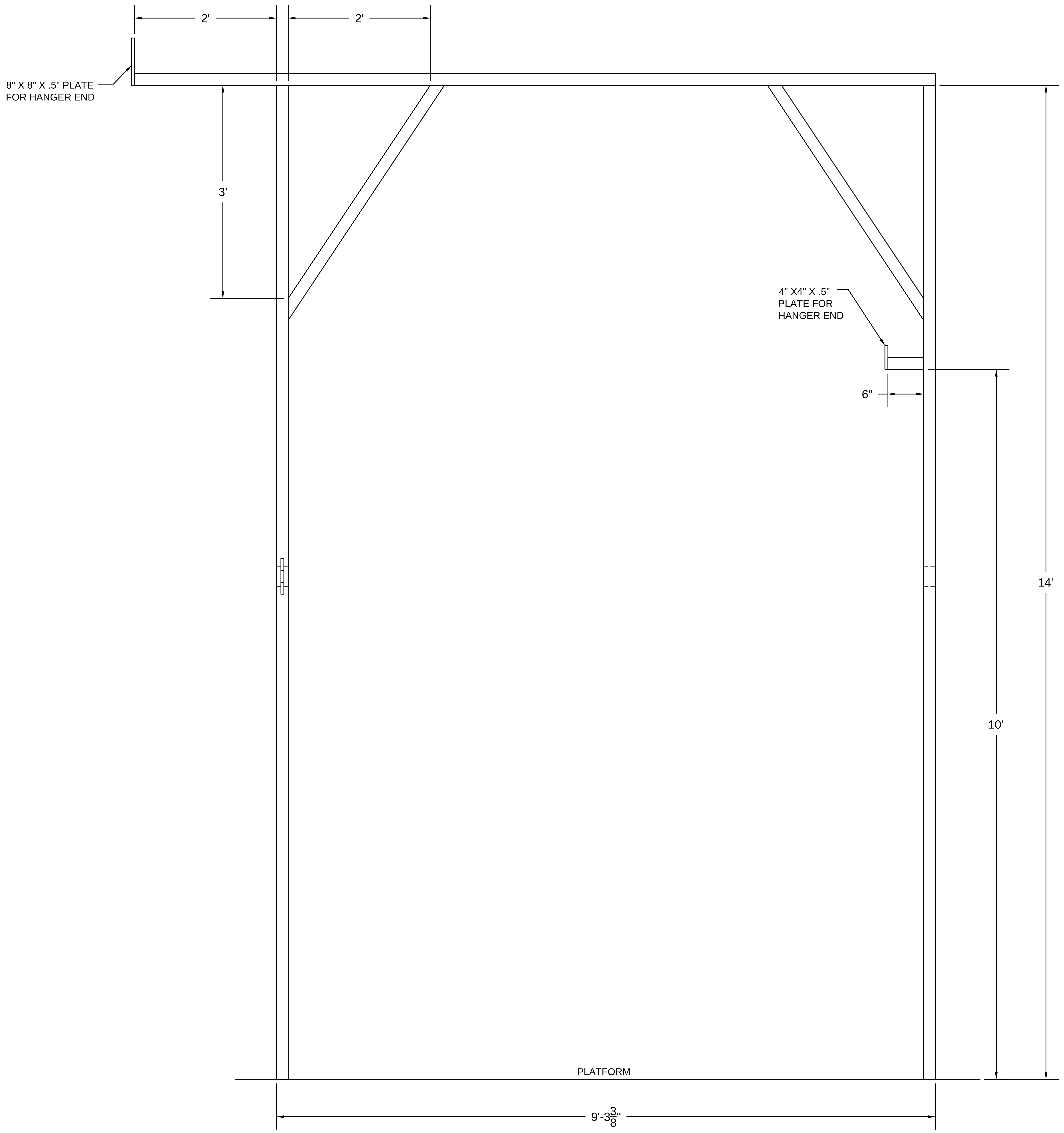
DWG RELEASE RECORD			
PROJECT NO. 88881	FILENAME 88881-S2	DRAWN BY pol	CHK'D BY mdr
DRAWING NO. S2			

ACCESS PLATFORMS
ELEVATIONS

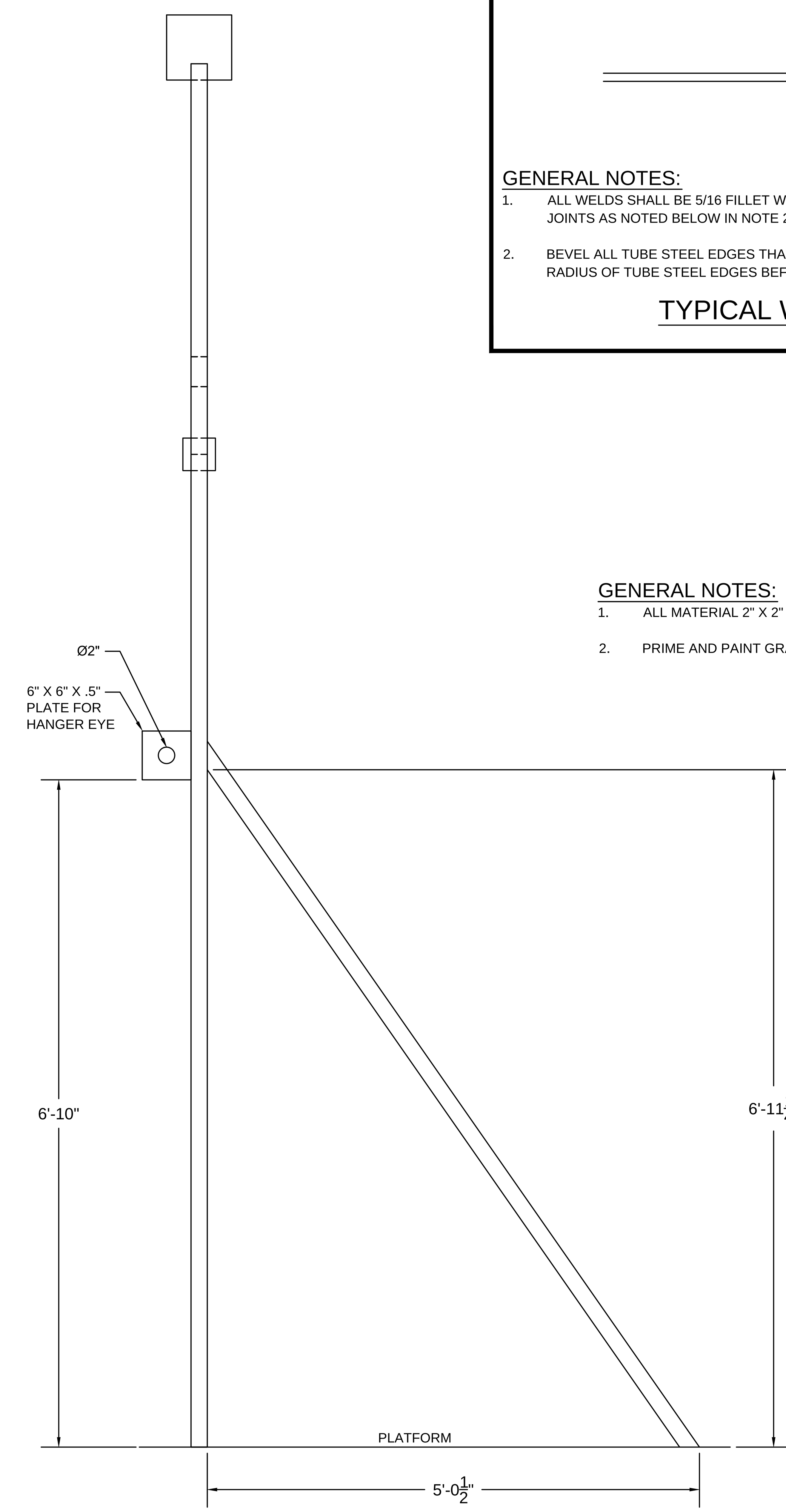
GENERATOR BUILDING
DUCT ACCESS PLATFORMS
MANITOWOC PUBLIC UTILITY
MANITOWOC, WO

BOLDT Technical Services
2525 N. ROEMER RD. P.O. BOX 419
APPLETON, WI 54912-0419 920-739-63

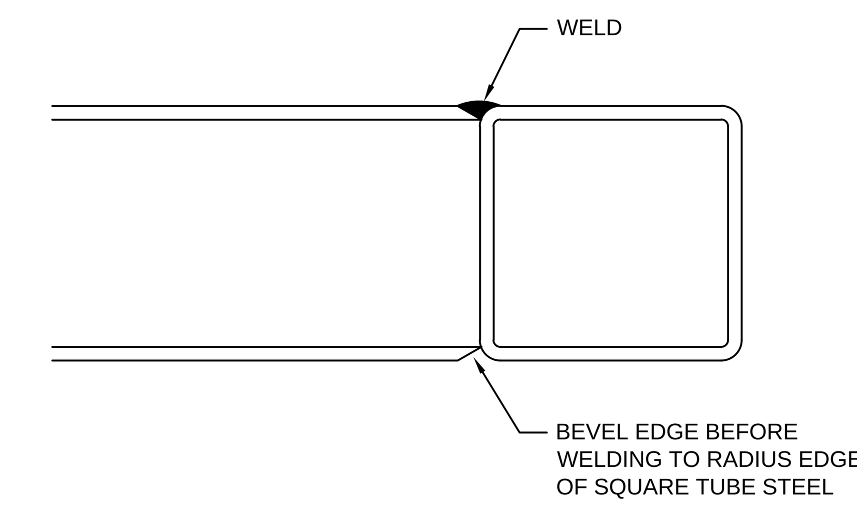
MPU04164



NORTH ELEVATION
SCALE: 1" = 1' (22 X34)
SCALE: 1/2" = 1' (11 X 17)



WEST ELEVATION
SCALE: 1" = 1' (22 X34)
SCALE: 1/2" = 1' (11 X 17)



GENERAL NOTES:
1. ALL WELDS SHALL BE 5/16 FILLET WELDS EXCEPT JOINTS AS NOTED BELOW IN NOTE 2.
2. BEVEL ALL TUBE STEEL EDGES THAT MATE WITH RADIUS OF TUBE STEEL EDGES BEFORE WELDING.

TYPICAL WELDING DETAIL

GENERAL NOTES:
1. ALL MATERIAL 2" X 2" X .180" WALL SQUARE TUBING UNLESS OTHERWISE NOTED.
2. PRIME AND PAINT GRAY COLOR.

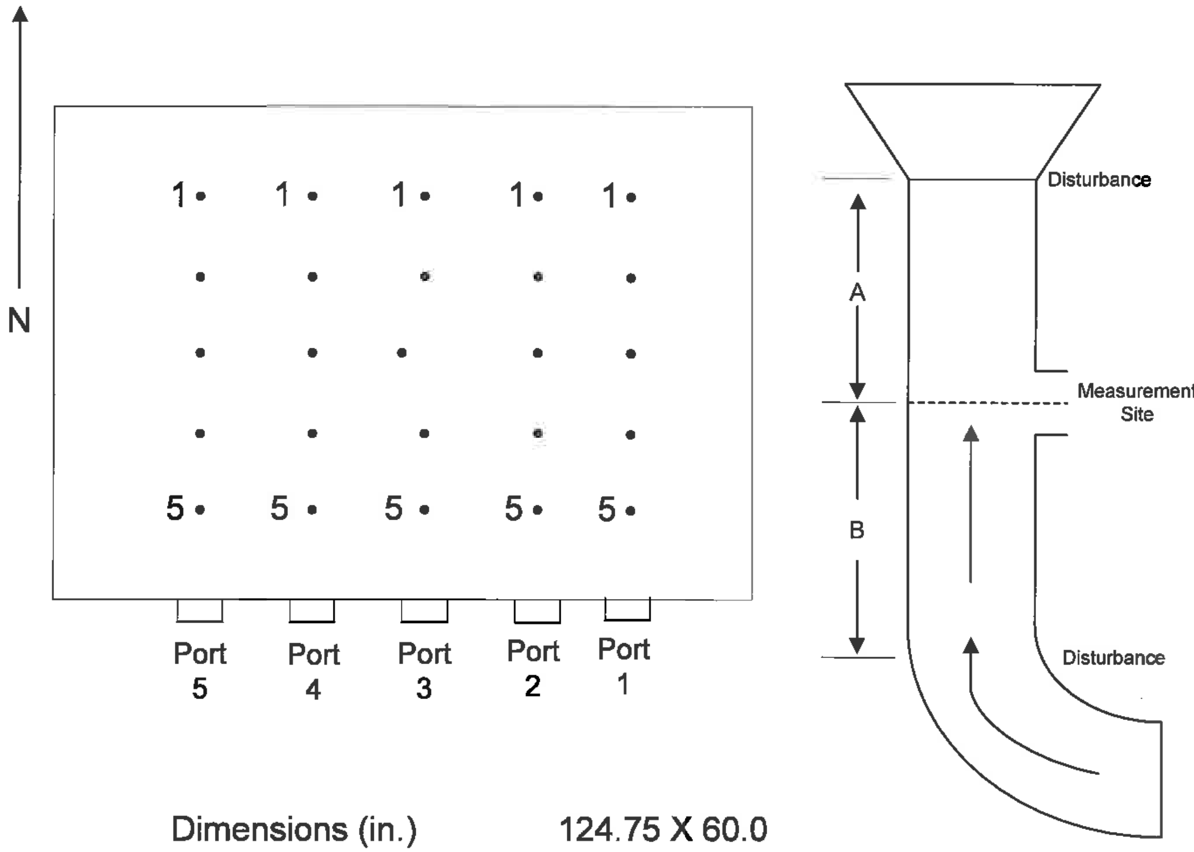
NO.	DATE	BY	REVISION

TITLE:

BOILER 9 STACK TEST FRAME

MANITOWOC PUBLIC UTILITIES
MANITOWOC, WISCONSIN

DATE: 05-04-2010
DRAWN BY: CMJ
CHECKED BY: T. REED
SCALE: AS NOTED
DEPARTMENT: PP
TYPE: WORK ORDER
SHEET NUMBER:
6020-S1



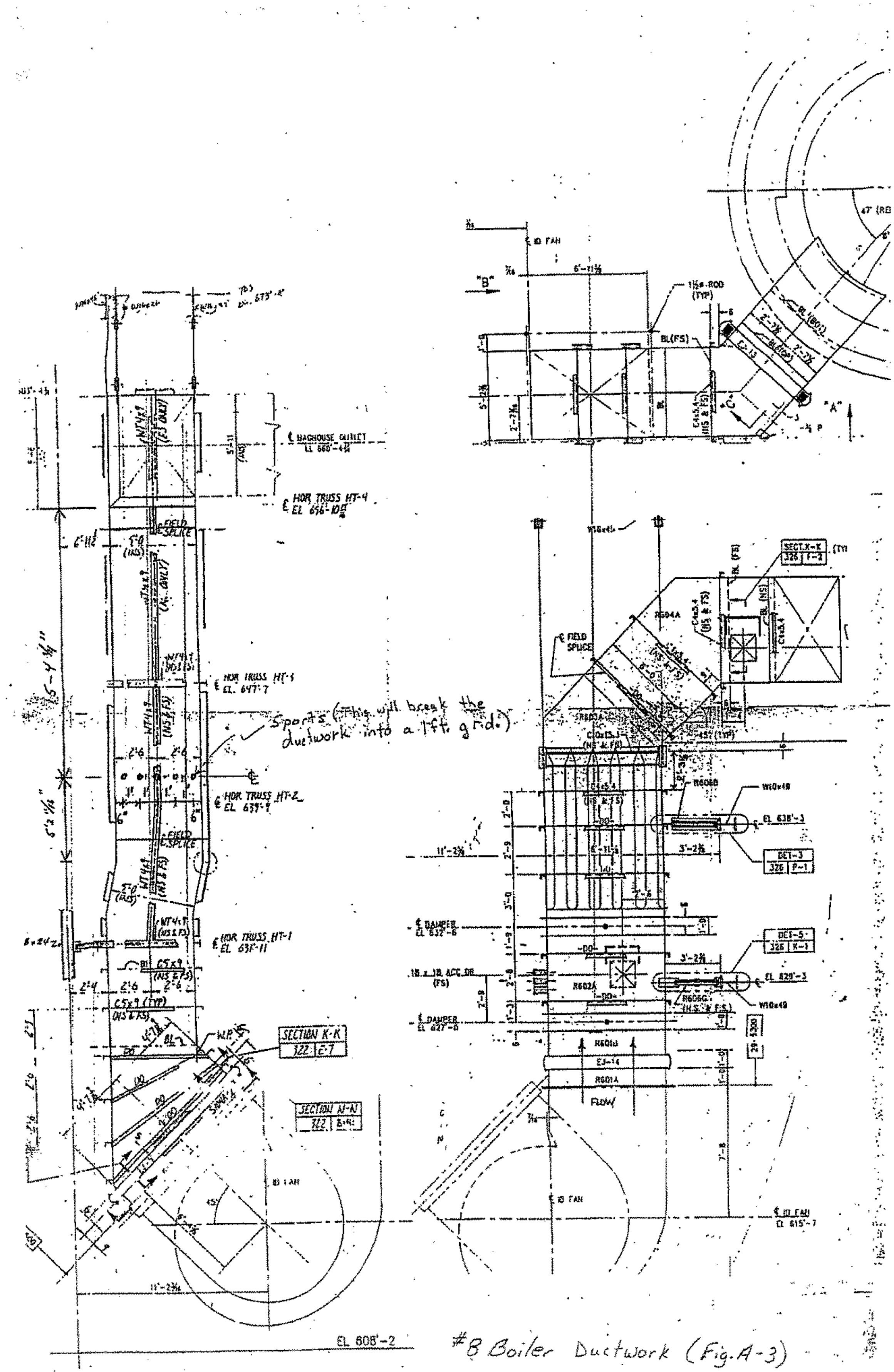
Dimensions (in.)	124.75 X 60.0
Port Length (in.)	12.0
Distance A (Duct Diameters)	8.9
Distance B (Duct Diameters)	4.4

Point	Distance From Wall (in.)
1	12.5
2	37.4
3	62.4
4	87.3
5	112.3

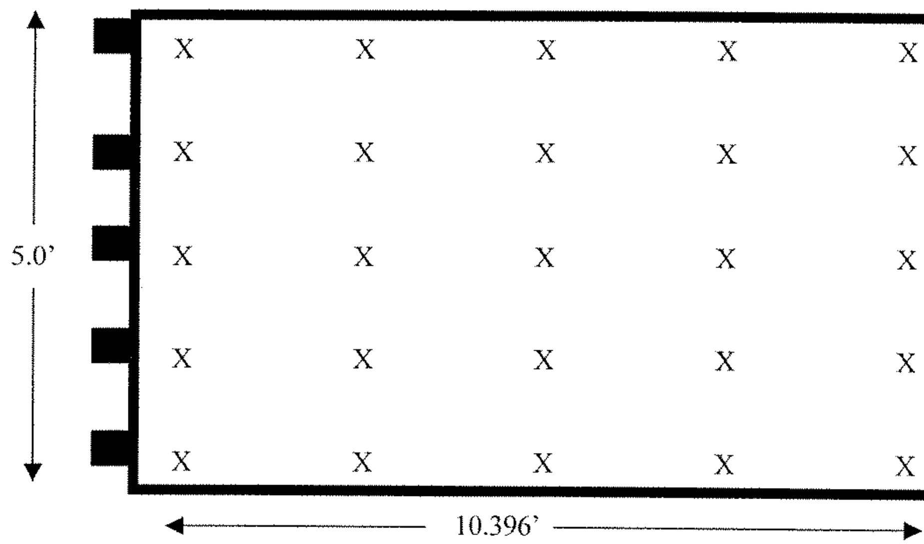
Cross Section of the Boiler 28 (B28) Test Location
Manitowoc Public Utilities

Figure 2

AIRTECH Environmental Services Inc.



#8 Boiler Ductwork (Fig. A-3)



Job: Manitowoc Public Utilities
Manitowoc, Wisconsin

Area: 51.979 Square Feet

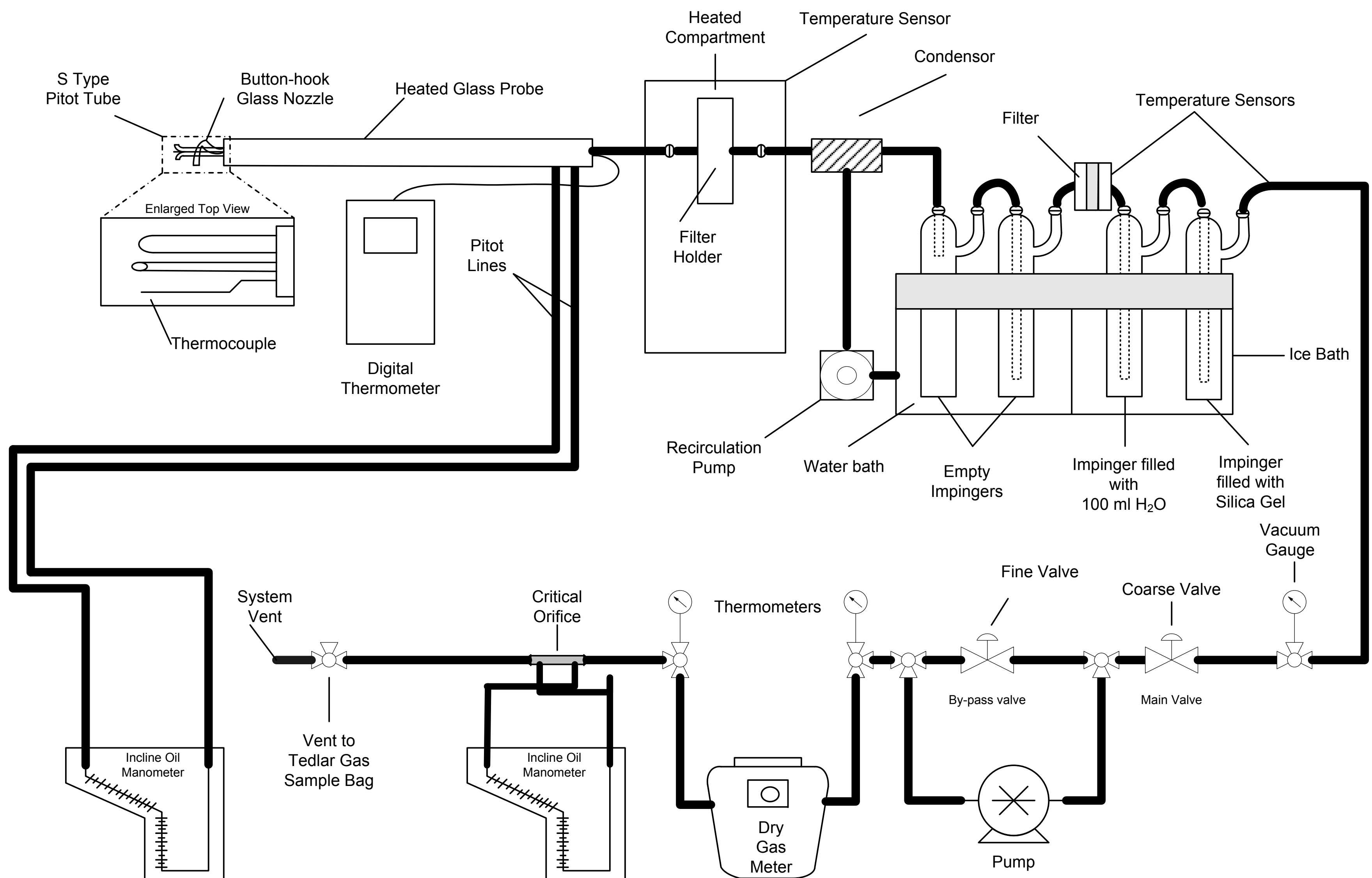
Unit Location: Boilers B28

No. Test Ports: 5

Length: 10 Feet 4.75 Inches

Tests Points per Port: 5

Width: 5.0 Feet



EPA Methods 2, 4, 5 and 202:
Total Particulate Sampling Train

Figure 3

AIRTECH Environmental Services Inc.

MPU04169

Sample Calculations

Area of Sample Location

$$A_s = \pi \times \left(\frac{d}{2}\right)^2$$

where:

A_s	= area of sample location (ft^2)
d	= stack diameter (ft)
2	= conversion factor (diameter to radius)

Stack Pressure Absolute

$$P_a = P_b + \frac{P_s}{13.6}$$

where:

P_a	= stack pressure absolute (in. Hg)
P_b	= barometric pressure (in. Hg)
P_s	= static pressure (in. H_2O)
13.6	= conversion factor (in. H_2O/in Hg)

Volume of Dry Gas Collected Corrected to Standard Temperature and Pressure

$$V_{m(std)} = \frac{17.64(V_m)(Y_d)\left(P_b + \frac{\Delta H}{13.6}\right)}{(T_m + 460)}$$

where:

$V_{m(std)}$	= volume of gas collected at standard temperature and pressure (scf)
V_m	= volume of gas sampled at meter conditions (ft^3)
Y_d	= gas meter correction factor (dimensionless)
P_b	= barometric pressure (in. Hg)
ΔH	= average sample pressure (in. H_2O)
T_m	= average gas meter temperature (^oF)
13.6	= conversion factor (in. H_2O/in Hg)
17.64	= ratio of standard temperature over standard pressure (^oR/in.Hg)
460	= conversion (^oF to ^oR)

Volume of Water Vapor Collected Corrected to Standard Temperature and Pressure

$$V_{w(std)} = 0.04707 \times V_{wc} + 0.04715 \times V_{wsg}$$

where:

$V_{w(std)}$	= volume of water vapor at standard conditions (scf)
V_{wc}	= weight of liquid collected (g)
V_{wsg}	= weight gain of silica gel (g)
0.04707	= volume occupied by one milliliter of water at standard temperature and pressure (ft^3/ml)
0.04715	= volume occupied by one gram of water at standard temperature and pressure (ft^3/g)

Percent Moisture[1]

$$B_{ws} = 100 \times \left[\frac{V_{w(std)}}{\left(V_{m(std)}\right) + V_{w(std)}\right)} \right]$$

where:

B_{ws}	= moisture content of the gas stream (%)
$V_{m(std)}$	= volume of gas collected at standard temperature and pressure (scf)
$V_{w(std)}$	= volume of water vapor at standard conditions (scf)
100	= conversion factor

Molecular Weight of Dry Gas Stream[2]

$$M_d = \left(44 \times \frac{\%CO_2}{100}\right) + \left(32 \times \frac{\%O_2}{100}\right) + \left(28 \times \frac{(\%N_2)}{100}\right)$$

where:

M_d	= molecular weight of the dry gas stream (lb/lb-mole)
$\%CO_2$	= carbon dioxide content of the dry gas stream (%)
44	= molecular weight of carbon dioxide (lb/lb-mole)
$\%O_2$	= oxygen content of the dry gas stream (%)
32	= molecular weight of oxygen (lb/lb-mole)
$\%N_2$	= nitrogen content of the dry gas stream (%)
28	= molecular weight of nitrogen (lb/lb-mole)
100	= conversion factor

[1] The moisture saturation point will be used for all calculations if it is exceeded by the actual moisture content.
[2] The remainder of the gas stream after subtracting carbon dioxide and oxygen is assumed to be nitrogen.

Molecular Weight of Wet Gas Stream

$$M_s = \left(M_d \times \left(1 - \frac{B_{ws}}{100}\right)\right) + \left(18 \times \frac{B_{ws}}{100}\right)$$

where:

M_s	= molecular weight of the wet gas stream (lb/lb-mole)
M_d	= molecular weight of the dry gas stream (lb/lb-mole)
B_{ws}	= moisture content of the gas stream (%)
18	= molecular weight of water (lb/lb-mole)
100	= conversion factor

Velocity of Gas Stream

$$V_s = 85.49\left(C_p\right)\left(\sqrt{\Delta P}\right)\sqrt{\frac{\left(T_s + 460\right)}{\left(M_s\right)\left(P_b + \frac{P_s}{13.6}\right)}}$$

where:

V_s	= average velocity of the gas stream (ft/sec)
C_p	= pitot tube coefficient (dimensionless)
$\sqrt{\Delta P}$	= average square root of velocity pressures (in. H_2O)$^{1/2}$
Ts	= average stack temperature (^oF)
Ms	= molecular weight of the wet gas stream (lb/lb-mole)
Pb	= barometric pressure (in. Hg)
Ps	= static pressure of gas stream (in. H_2O)
85.49	= pitot tube constant (ft/sec)([(lb/lb-mole)(in. Hg)]/[(^oR)(in. H_2O)])$^{1/2}$
460	= conversion (^oF to ^oR)
13.6	= conversion factor (in. H_2O/in Hg)

Volumetric Flow of Gas Stream - Actual Conditions

$$Q_a = 60\left(V_s\right)\left(A_s\right)$$

where:

Q_a	= volumetric flow rate of the gas stream at actual conditions (acfm)
V_s	= average velocity of the gas stream (ft/sec)
A_s	= area of duct or stack (ft^2)
60	= conversion factor (sec/min)

Volumetric Flow of Gas Stream - Standard Conditions

$$Q_{std} = \frac{17.64(Q_a)\left(P_b + \frac{P_s}{13.6}\right)}{(T_s + 460)}$$

where:

Q_{std}	= volumetric flow rate of the gas stream at standard conditions (scfm)
Q_a	= volumetric flow rate of the gas stream at actual conditions (acfm)
T_s	= average stack temperature (^oF)
P_b	= barometric pressure (in. Hg)
P_s	= static pressure of gas stream (in. H_2O)
13.6	= conversion factor (in. H_2O/in Hg)
17.64	= ratio of standard temperature over standard pressure (^oR/in.Hg)
460	= conversion (^oF to ^oR)

Volumetric Flow of Gas Stream - Standard Conditions - Dry Basis

$$Q_{dstd} = Q_{std}\left(1 - \frac{B_{ws}}{100}\right)$$

where:

Q_{dstd}	= volumetric flow rate of the gas stream at standard conditions, on a dry basis (dscfm)
Q_{std}	= volumetric flow rate of the gas stream at standard conditions (scfm)
B_{ws}	= moisture content of the gas stream (%)
100	= conversion factor

Area of Nozzle

$$A_n = \pi \times \left(\frac{d_n}{2 \times 12} \right)^2$$

where:

An	= area of nozzle (ft2)
dn	= diameter of nozzle (in)
12	= conversion factor (in/ft)
2	= conversion factor (diameter to radius)

Percent Isokinetic

$$I = \frac{0.0945 (T_s + 460)(V_{m(std)})}{\left(P_b + \frac{P_s}{13.6} \right)(v_s)(A_n)(\Theta)\left(1 - \frac{B_{ws}}{100} \right)}$$

where:

I	= percent isokinetic (%)
T_s	= average stack temperature (^oF)
$V_{m(std)}$	= volume of gas collected at standard temperature and pressure (scf)
P_b	= barometric pressure (in. Hg)
P_s	= static pressure of gas stream (in. H_2O)
V_s	= average velocity of the gas stream (ft/sec)
A_n	= cross sectional area of nozzle (ft^2)
Θ	= sample time (min)
B_{ws}	= moisture content of the gas stream (%)
0.0945	= conversion (^oF to ^oR)
13.6	= conversion factor (in. H_2O/in Hg)
100	= conversion factor

Acetone Wash Blank

$$W_a = \frac{(m_{ab})(v_{aw})}{v_{awb}}$$

where:

W_a	= particulate mass in acetone wash blank (g)
m_{ab}	= mass collected, acetone wash blank (g)
v_{aw}	= volume of wash (ml)
v_{awb}	= volume of acetone wash blank (ml)

Total Particulate Catch

$$M_n = m_f + (m_a - W_a)$$

where:

M_n	= total particulate catch (g)
m_f	= particulate on filter (g)
m_a	= particulate in wash (g)
W_a	= particulate mass in acetone wash blank (g)

Particulate Concentration, grains/dscf

$$C = \frac{(M_n)(15.43)}{V_{m,std}}$$

where:

C	= particulate concentration (grains/dscf)
M_n	= total particulate catch (g)
$V_{m(std)}$	= volume of gas collected at standard temperature and pressure (dscf)
15.43	= conversion factor (grains/gram)

Particulate Emission Rate (lb/hr)

$$E_{lb/hr} = \frac{(M_n)(Q_{dstd})(60)}{(V_{m,std})(453.6)}$$

where:

$E_{lb/hr}$	= particulate emission rate (lb/hr)
M_n	= total particulate catch (g)
$V_{m(std)}$	= volume of gas collected at standard temperature and pressure (scf)
Q_{dstd}	= volumetric flow rate of the gas stream at standard conditions, on a dry basis (dscfm)
60	= conversion factor (min/hr)
453.6	= conversion factor (g/lb)

Sample Calibration Sheets

Airtech Environmental Services, Inc.
Meter Box Full Test Calibration

Date: Operator:

Meter Box ID	Meter Box ΔH@	Meter Box Y_d	Barometric Pressure (in. Hg.)

Time	Orifice Data				Meter Box Data								Results		
θ (min)	K'	Vacuum	T_{amb}	V_{cr}	$V_{initial}$	V_{final}	V_d	ΔH	T_i	T_o	T_{avg}	V_{mstd}	Q	Y_d	ΔH@
													Average		

Nomenclature	
K'	Critical Orifice Coefficient
T_{amb}	Ambient Temperature (°F)
V_{cr}	Volume Through Orifice (scf)
V_d	Gas Meter Volume (ft^3)
ΔH	Orifice Pressure Differential (in. H_2O)
T_i	Meter Inlet Temperature (°F)
T_o	Meter Outlet Temperauture (°F)
T_{avg}	Average Meter Box Temperature (°F)
V_{mstd}	Volume Metered Standardized (scf)
Q	Flow Rate (scfm)
Y_d	Meter Correction Factor (dimensionless)
ΔH@	ΔH yielding 0.75 scfm

Vacuum Guage (in. Hg.)		Thermometers (°F)		
Standard	Vacuum Gauge	Standard	DGM Inlet	DGM Outlet

Equations

$$V_{cr} = \frac{K' * P_b * \theta}{(T_{amb} + 460) \wedge 0.5}$$

$$V_{mstd} = \frac{17.64 * V_d * (P_b + (\Delta H/13.6))}{(T_{avg} + 460)}$$

$$Q = V_{cr} / \theta$$

$$Y_d = V_{cr} / V_{mstd}$$

$$\Delta H@ = \frac{.0319 * \Delta H * (T_{avg} + 460) * \theta\wedge 2}{P_b * Y_d\wedge 2 * V_m\wedge 2}$$

Airtech Environmental

Post Test Meter Calibration

Average Field Sample Rate (cfm)		Date	
Highest Field Vacuum (inches Hg)		Client	
Critical Orifice ID		Project No.	
Orifice Flow Rate (cfm)		Meter ID	

	Run 1	Run 2	Run 3	
Initial Volume (ft^3)				
Final Volume (ft^3)				
Volume Metered (ft^3)				
DGM Inlet Temperature (^oF)				
DGM Outlet Temperature (^oF)				
Average DGM Temperature (^oF)				
Ambient Temperature (^oF)				
Elapsed Time (min.)				
ΔH (inches H_2O)				
Barometric Pressure (inches Hg)				
Pump Vacuum (inches Hg)				
K'				
Vcr (ft^3)				
Vmstd (ft^3)				
Post Test Yc				
Full Test Yd				
% Difference				
	Average Difference			

Sample Data Sheets

Airtech Environmental Services, Inc.

Method 1 Data Sheet

LOCATION ______________________________

Client	
Project No:	
Plant	
Date	
Technician	
Duct Diameter (in.)	
Port Diameter (in.)	
Port Length (in.)	
Port Type	
Distance A (ft)	
Distance B (ft)	
Distance A (Duct Diameters)	
Distance B (Duct Diameters)	

[N] [Up]

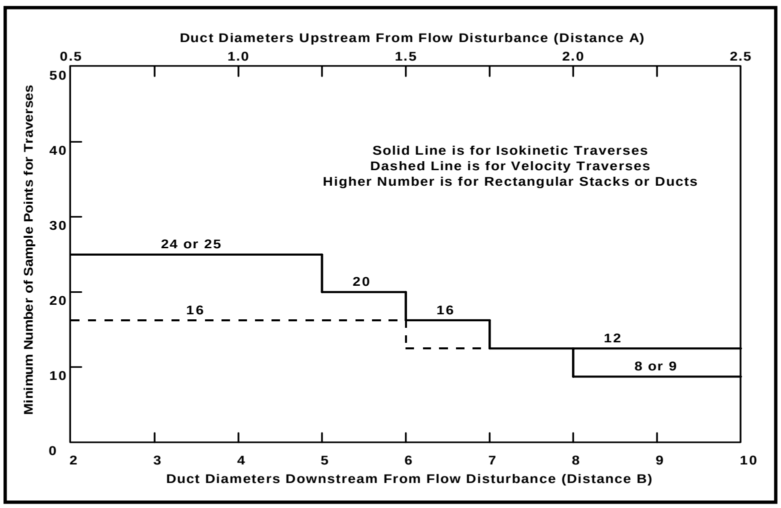
First point all the way [in] [out]

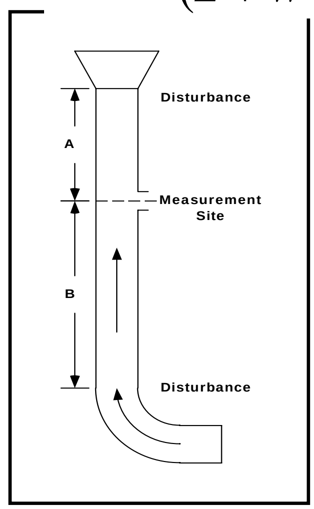
Gas flow [in] [out] of page

Cross Section of Duct

For rectangular ducts

$$ED = \frac{2LW}{(L+W)}$$





Location Schematic and Notes	**Traverse Point**	**Distance (in.)**
	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	10	
	11	
	12	
	13	
	14	
Indicate sample ports, height from grade, types of disturbances, access, unistrut configuration, etc.	**15**	
Distance to point must include length of port	**16**	

MPU04181

AIRTECH ENVIRONMENTAL SERVICES INC.

Oxygen and Carbon Dioxide Data Sheet

PROJECT NO. ______________

Page		of	

Client			
Plant			
Location		Date	
Analyzer Type		Leak Check	

$$F_O = \frac{(20.9 - O_2\%)}{CO2\%}$$

Run No.	Trial No.	$\%CO_2$	$\%CO_2+\%O_2$	$\%O_2$	F_O	Analyst	Date	Time
	1							
	2							
	3							
	Average							
	1							
	2							
	3							
	Average							
	1							
	2							
	3							
	Average							
	1							
	2							
	3							
	Average							
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	3							
	Average							
	1							
	2							
	3							
	Average							
	1							
	2							
	3							
	Average							
	1							
	2							
	3							
	Average							
	1							
	2							
	3							
	Average							

Notes:

Measurements must be made to the nearest 0.2%.

Three different trails should be performed for each sample.

The differences between the trials must not be greater than 0.2% overall.

Run an ambient air check to verify Oxsorb.

Expected F_o Ranges

Anthracite/Lignite	1.015-1.130	Nat. Gas	1.600-1.836
Bituminous	1.083-1.230	Wood Bark	1.000-1.120
Distillate Oil	1.260-1.413	Municiple	
Residual Oil	1.210-1.370	Garbage	1.043-1.177

MPU04182

AIRTECH ENVIRONMENTAL SERVICES INC.

General Testing Data Sheet

TESTING TYPE: ____________________________

RUN NO. ____________________ **METHOD NO.** ________________ **Page** ______ **of** ______

Client							
Plant							
Location							
Date			Project No.				
Meter Operator							
Probe Operator							
Meter ID		Yd		Pitot Cp			
$\Delta H@$		Kf		Leak check			
Pre Leak Check		[cfm] [lpm] @		(inHg)			
Post Leak Check		[cfm] [lpm] @		(inHg)			

[N] [Up]

First point all the way [in] [out]

Gas flow [in] [out] of page

Cross Section of Duct

Barometric (inHg)		Water [ml] [g]	
Ambient Temp (^{0}F)		Silica gel (g)	
Static (inH$_2$O)		Total Vlc	
Probe ID		Liner Type	
Nozzle ID		Nozzle Dia (in)	
Filter ID			
Train ID		Train Type	
Duct Dim. (in)		Port Lngth (in)	
Start Time		Stop Time	

Traverse Point	Min/Point Elapsed Time	Velocity Pressure ΔP (inH$_2$O)	Orifice Setting ΔH (inH$_2$O)	Gas Sample Volume Initial [f^3] [l]	Stack Temp (^{0}F)	Probe Temp (^{0}F)	Filter Temp (^{0}F)	Impinger Outlet Temp (^{0}F)	DGM Inlet Temp (^{0}F)	DGM Outlet Temp (^{0}F)	Pump Vacuum (inHg)	Auxiliary Temp (^{0}F)		Notes
Total														
Average														

Circle correct bracketed [ ] units
Train Type denotes impingers, knockouts, etc.

MPU04183